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Upper Cross Stretches and Their Influence on Cardiac Autonomic Regulation: Insights from Heart Rate Variability Analysis

LMU-DCOM

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Abstract

Background: Upper Cross Syndrome represents a complex relationship that can affect muscles involved upper torso posture. SCM/trapezius stretching may enhance vagus nerve output and parasympathetic tone via HRV, as suggested by prior musculoskeletal studies, meriting osteopathic exploration.
Objectives: 1) Assess SCM/trapezius stretching versus no-stretch on vagal HRV metrics in a single-blind crossover trial.
2) Compare performance of consumer-grade armband HRV device vs electrode-based device.
Methods: IRB approval through LMU-DCOM. Nineteen healthy participants (Mean age: 25.7 ± 1.9 years; 53% Female, 47% Male) completed sessions in a randomized crossover manner: stretch (SCM/trapezius) or control, with pre/post HRV via photoplethysmography and electrode-based devices (Rhythm24 armband with EliteHRV app and Sphygmacor, respectively). Time/frequency-domain metrics underwent t-tests (SPSS; α=0.05); device concordance evaluated.
Results: Stretch yielded no significant parasympathetic HRV changes (Rhythm24 RMSSD: 5.54 vs. 9.13 ms, p=0.482; SphygmoCor lnRMSSD: 8.27 vs. 10.13, p=0.672). Trends: higher post-stretch MeanHR/MeanRRInterval (p=0.093-0.100). Second sessions increased variability (SphygmoCor MeanHR: 3.50 vs. 1.94 bpm, p=0.029), suggesting order effects. Devices aligned (RMSSD p=0.481). No adverse events.
Conclusions: No significant vagal enhancement from SCM/trapezius stretching; small-moderate effects merit larger studies. Device reliability should inform future HRV research in osteopathy.

Introduction

Heart rate Variability (HRV) is the measure of the time from the R wave of one cardiac cycle to the next (R-to-R interval; R-R). With every cardiac cycle, there are a few milliseconds of difference between cycles due to the dynamic input the heart receives and adjusts for from the autonomic nervous system. HRV therefore can be viewed as an approximation of the sympathetic and parasympathetic systems[1]. Armband and electrode-based devices can non-invasively measure R-R intervals. HRV can be assessed in both the Time-domain (measuring every R-R against every other R-R) or the Frequency-domain (which assess the overall repeated cycles of R-R patterns over at least 5 minutes) **(Figure 1).**
The vagus nerve is responsible for the parasympathetic input to the heart. It exits the cranium through the jugular foramen and travels with the carotid artery and jugular vein within the carotid sheath, which lies posterior to the sternocleidomastoid (SCM) muscle **(Figure 2).** The SCM inserts on the mastoid process and lateral half of the superior nuchal line. The upper trapezius originates from the medial third of the superior nuchal line, external occipital protuberance, and nuchal ligament **(Figure 3).** Tension in either of muscle has the potential to affect the carotid sheath, which could affect vagus nerve output, potentially affecting HRV[2].

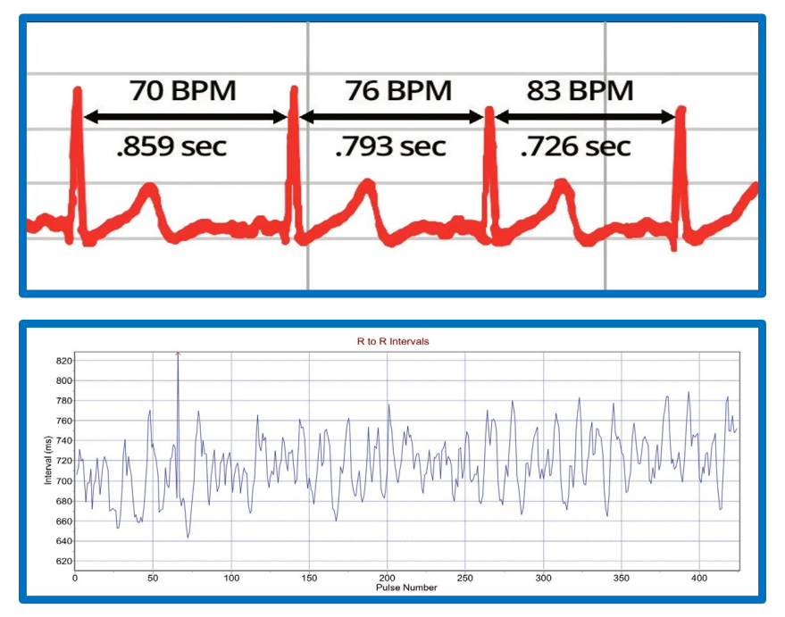

Figure 1. Time-domain and Frequency Domain

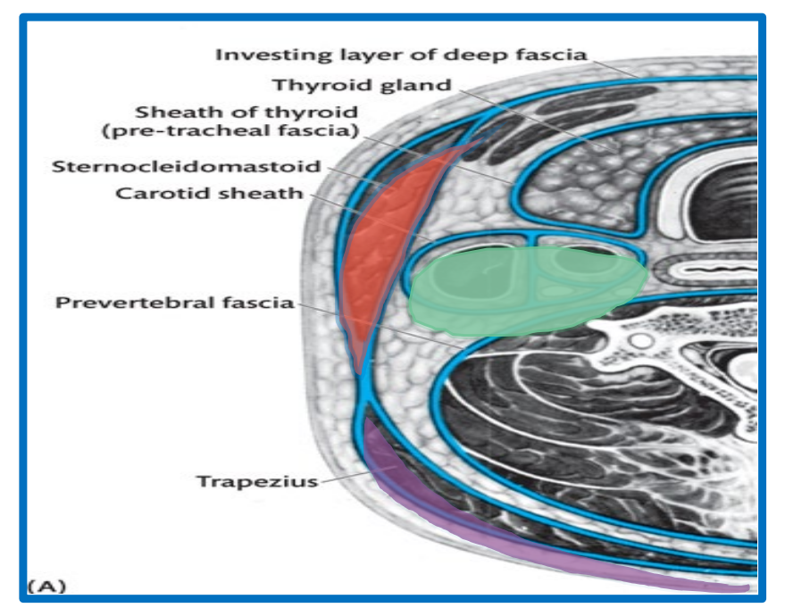

Figure 2. Axial cross-section of Cervical Neck[3] (Image Adapted)

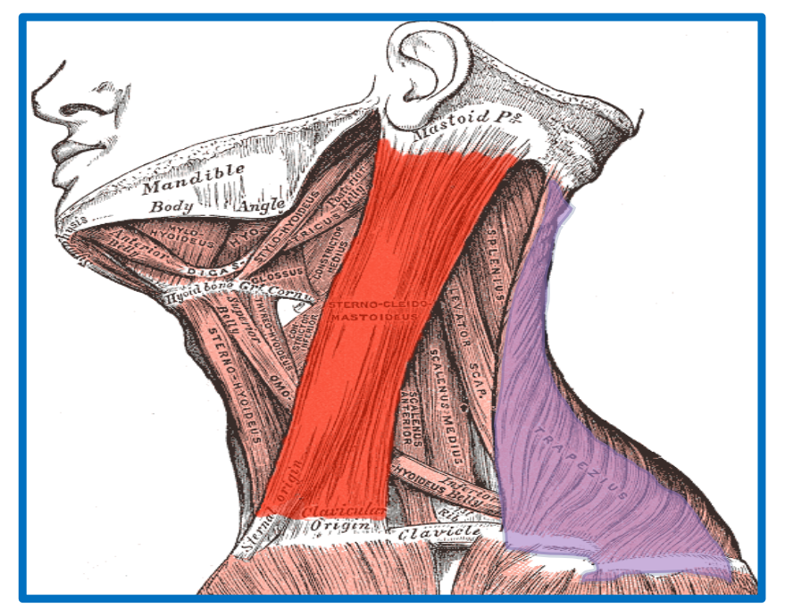

Figure 3. Musculature of lateral Cervical Neck[4] (Image Adapted)

Methods

19 healthy young volunteers (Mean age: 25.7 ± 1.9 years; 53% Female, 47% Male; no heart rate / rhythm affecting medications) provided informed consent for IRB-approved single blind crossover trial.

24 hours prior to session:
no vigorous workouts.
8 hours prior to session:
no caffeine or other stimulants.

Participants had a 5-minute HRV monitoring with armband device and EKG based device (**Figure 4**).

Recorder left the room, OPP Scholar led one of two randomly assigned 6-minute protocols: SCM stretching (**Figure 5)** or no stretching.

Figure 5. SCM stretch with Cervical Flexion, Side-bending Away, Rotation Towards target muscles.

Figure 4. Scoshce Rhythm 24 Armband and Sphygmacor System

After 6-minute protocol, recorder then returned and repeated measurements.

Second session ≥ 48 hours later within ± 1 hour time of day with other 6-minute protocol being completed.

Results

Nineteen subjects completed a single-blind crossover study examining sternocleidomastoid and trapezius stretching effects on heart rate variability, with measurements obtained across two sessions using Elite HRV and Sphygmocor devices simultaneously. 5-minute HRV measurements were taken before and after a 6-minute protocol.
Stretch versus No-Stretch Protocol: Mean heart rate was significantly elevated during the stretch protocol (M = 2.94 bpm, SD = 1.98) compared to no-stretch (M = 1.87 bpm, SD = 1.86), t(62) = 2.226, p = 0.030 **(Figure 6).**
Mean RR interval similarly increased with stretching (M = 31.19 ms, SD = 23.37 vs. M = 19.31 ms, SD = 20.75), t(62) = 2.146, p = 0.036 **(Figure 7)**.
Session Effects: Mean heart rate increased significantly from session 1 to session 2 (M = 1.88 bpm, SD = 1.45 vs. M = 3.00 bpm, SD = 2.31), t(62) = -2.340, p = 0.023 (**Figure 8**). Mean RR interval showed a similar trend approaching significance (M = 20.56 ms, SD = 15.43 vs. M = 30.63 ms, SD = 27.93), t(62) = -1.800, p = 0.077 **(Figure 9)**.
Device Comparison: No significant changes were measured for mean heart rate as measured between Rythm24 and Sphygmocor devices **(Figure 10).**Significant differences emerged in LF/HF ratio between devices (p = 0.009) **(Figure 11)**.

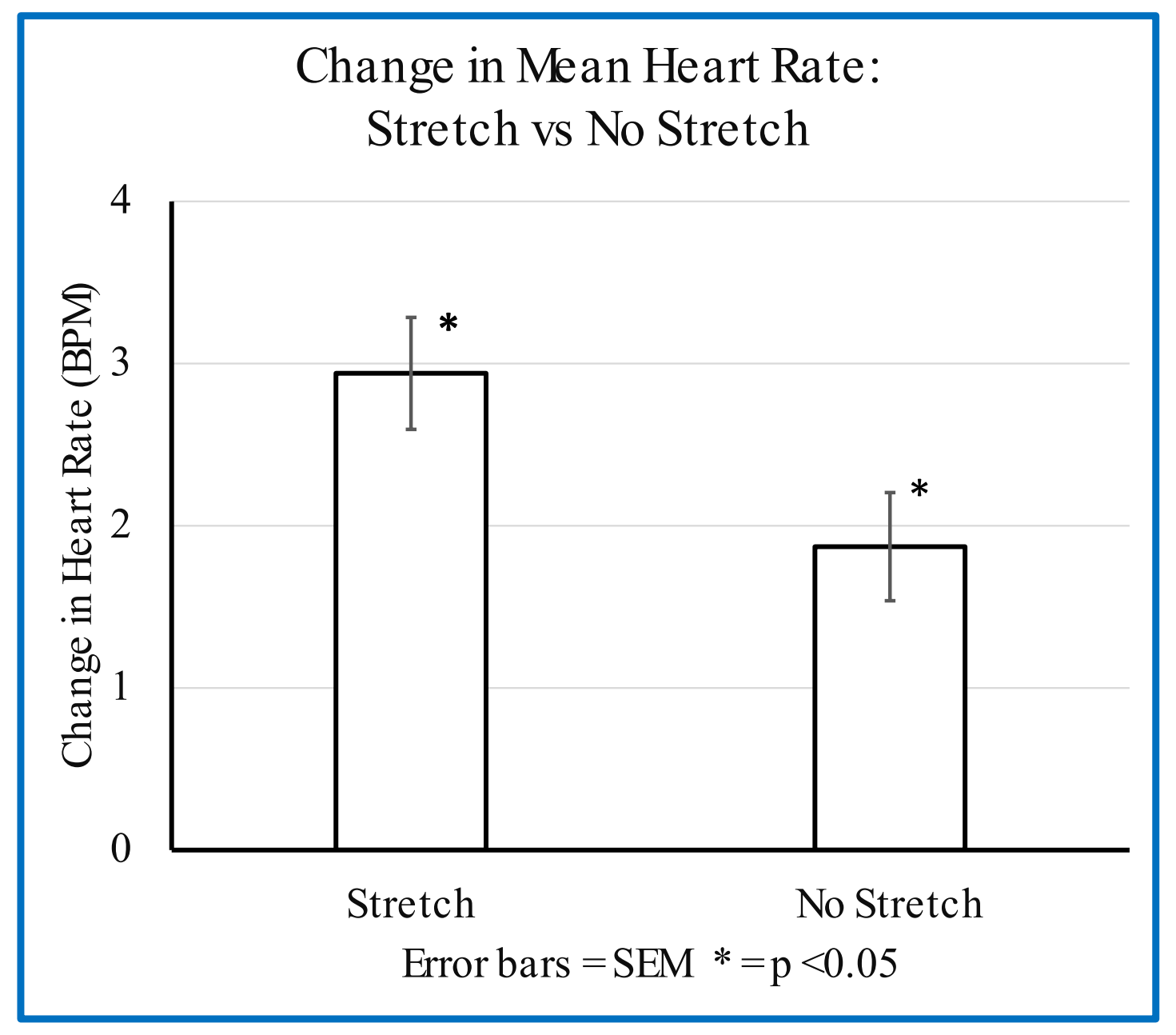

Figure 6. Change in Heart Rate by Protocol

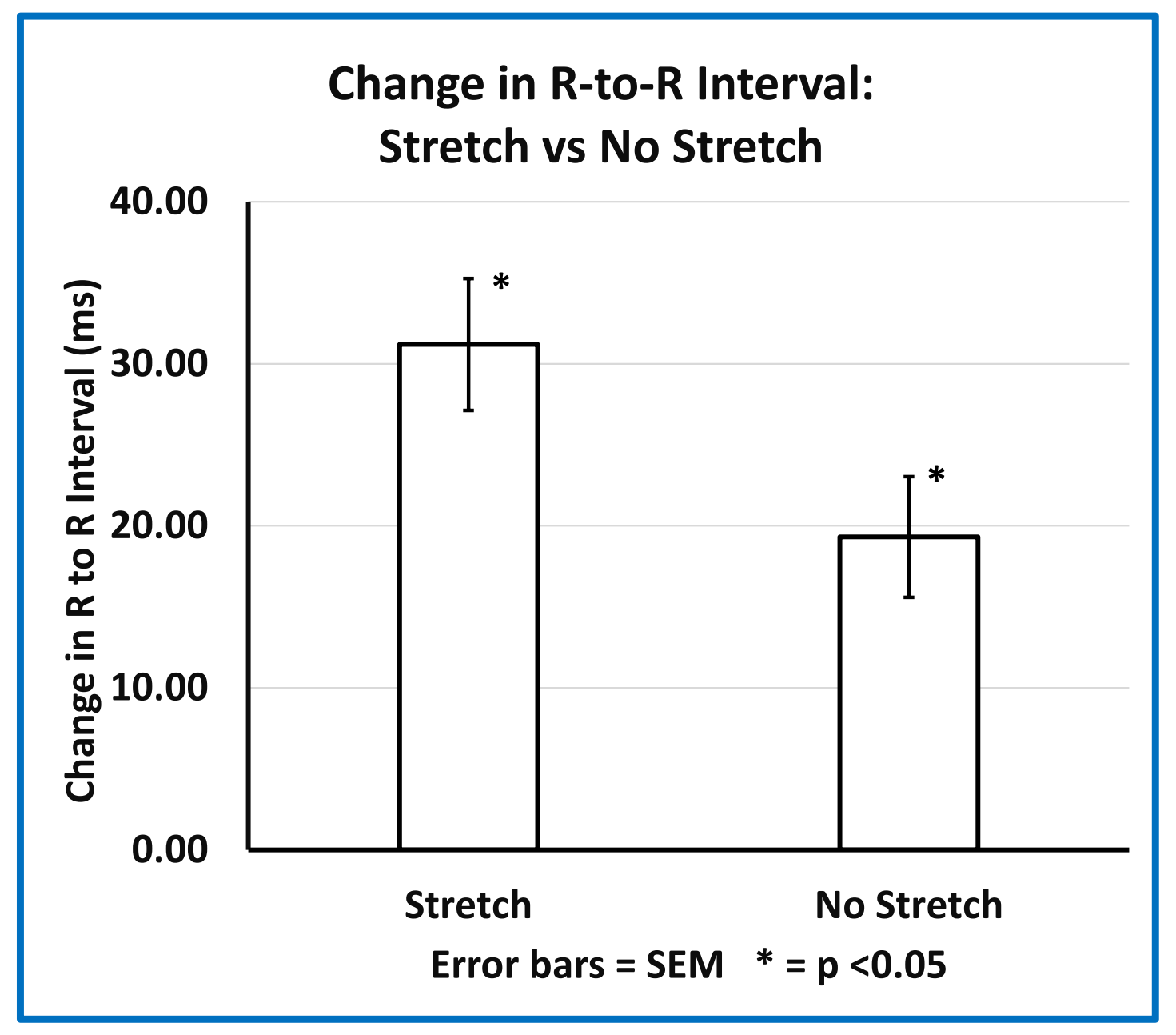

Figure 7. Change in R-to-R Interval by Protocol

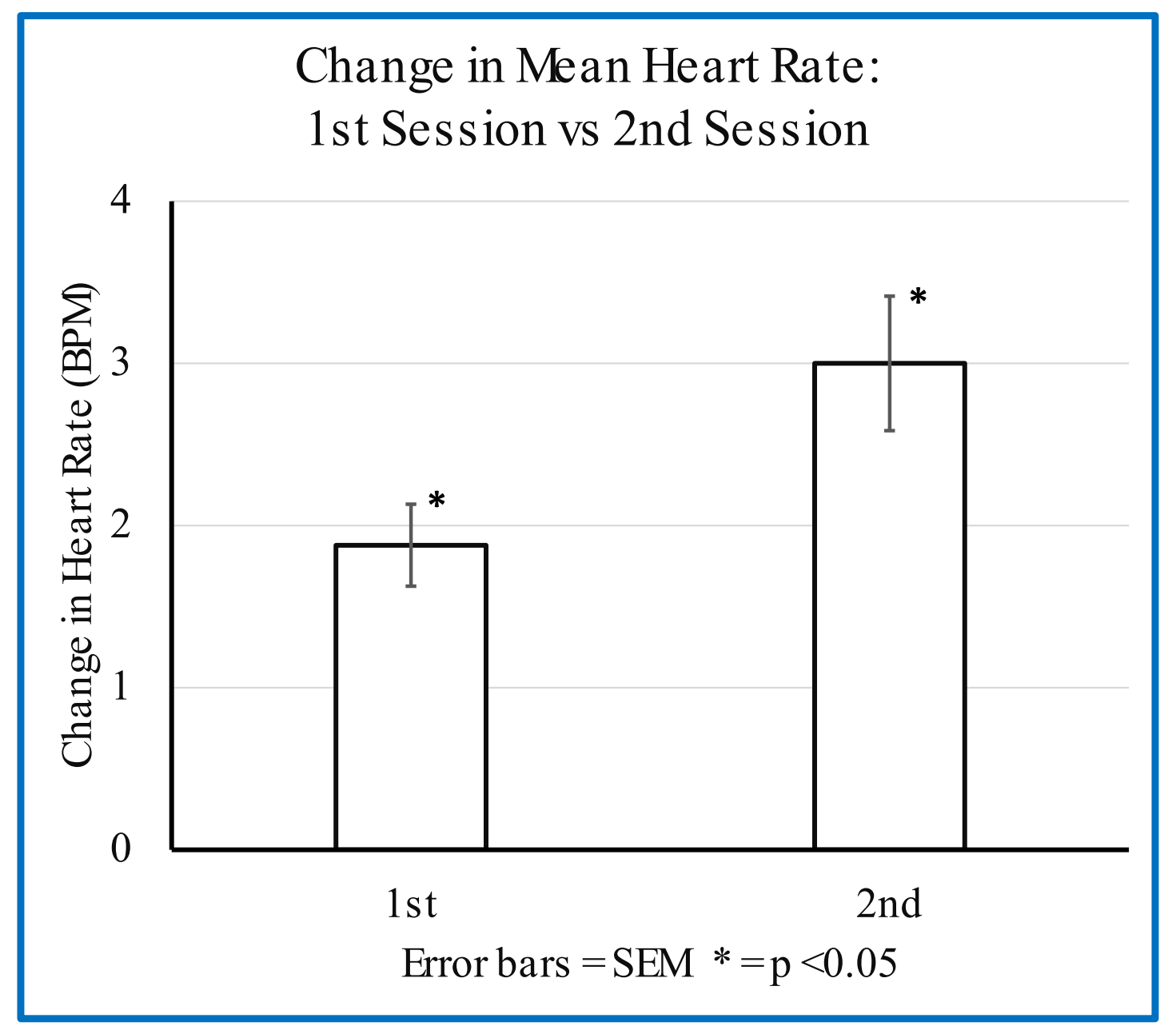

Figure 8. Change in Heart Rate by Session

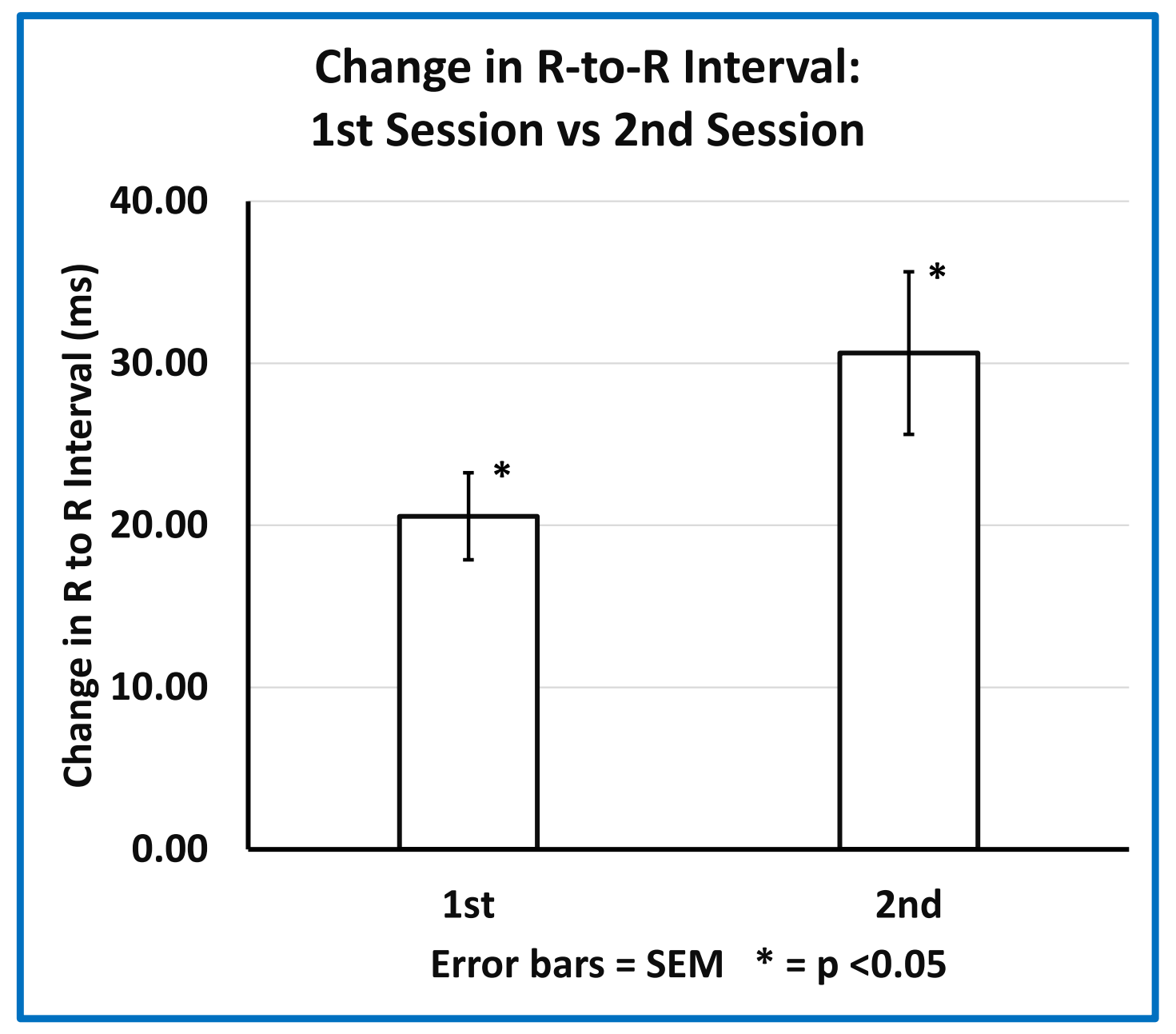

Figure 9. Change in R-to-R Interval by Session

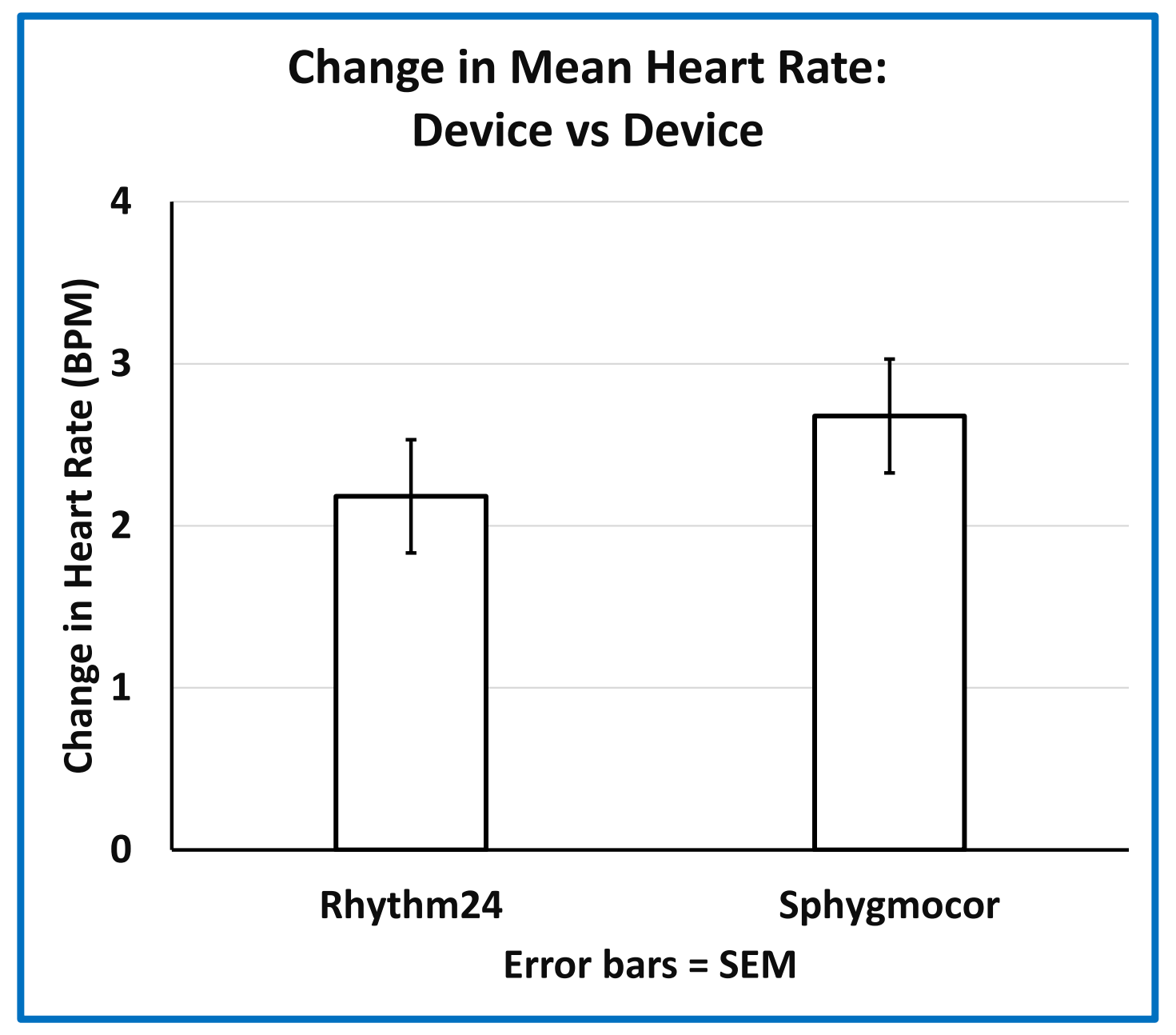

Figure 10. Change in Heart Rate by Device

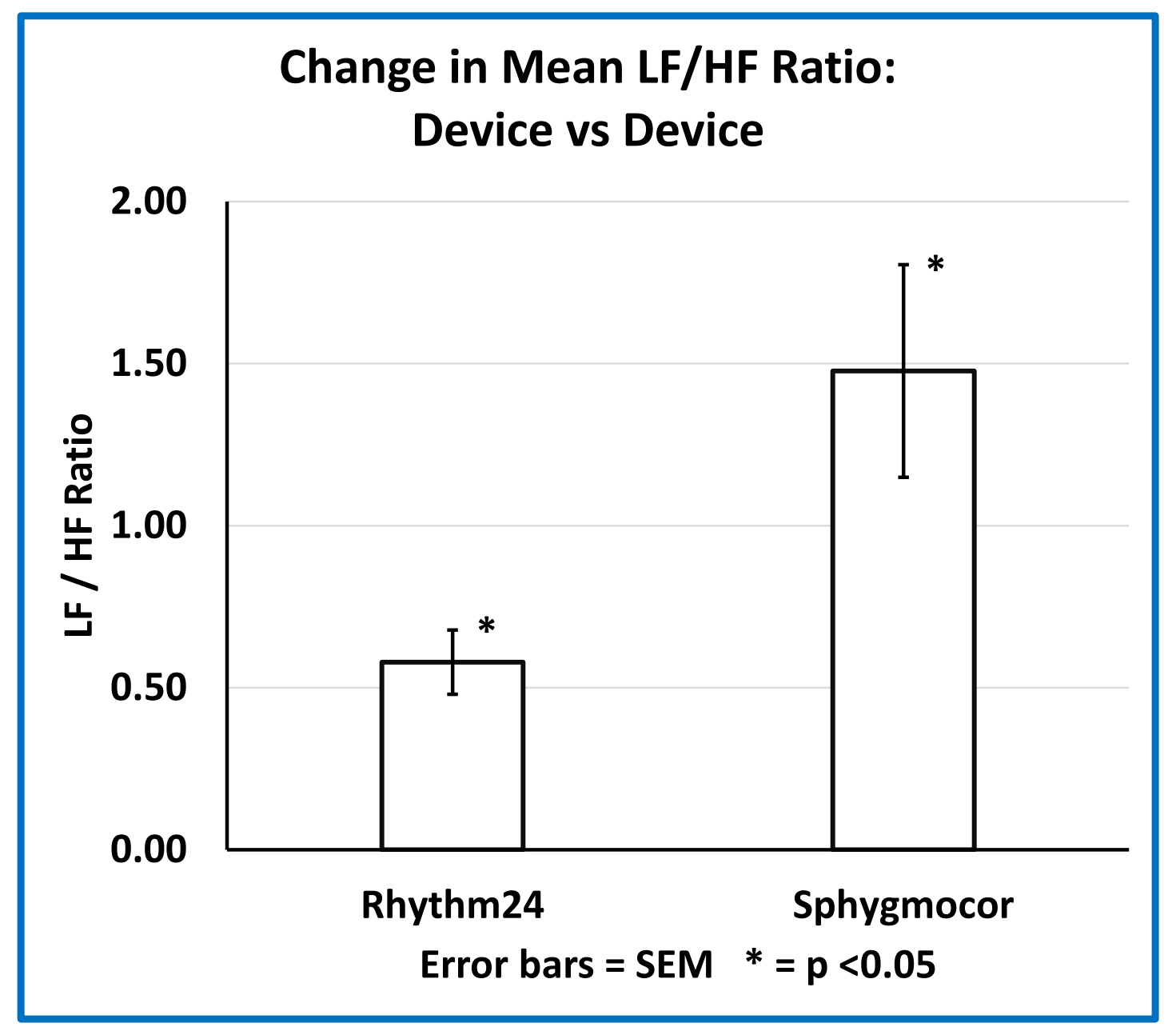

Figure 11. Change in LF / HF Ratio by Device

Discussion

Discussion: This study examined the acute effects of sustained sternocleidomastoid and trapezius muscle stretching on vagal output parameters measured through heart rate variability. The findings demonstrate complex cardiovascular responses to cervical stretching that warrant mechanistic interpretation within the context of autonomic nervous system physiology. No adverse events occurred during the measurement sessions. Circadian variations in HRV were accounted for by having by sessions be completed within ± 1 hour of time of day.
The statistically significant elevation in mean heart rate during the stretch protocol (t(62) = 2.226, p = 0.030) and increased RR interval (t(62) = 2.146, p = 0.036) present an unexpected pattern requiring nuanced discussion. Rather than confirming the hypothesized parasympathetic augmentation through vagal stimulation, these hemodynamic changes may reflect heightened sympathetic activation or reduced vagal tone during active cervical musculature engagement. One mechanistic explanation involves the metabolic demands and postural proprioceptive feedback generated during sustained stretch positioning, which could trigger reflexive autonomic shifts promoting cardiovascular mobilization despite manual manipulation intended to reduce upper cross syndrome tension. Alternatively, the observed HR elevation may reflect attentional focus and expectancy effects inherent to single-blind study design, wherein conscious awareness of experimental conditions influences baseline autonomic state independent of true vagal output modulation.
The significant device-specific divergence in LF/HF ratio measurements (p = 0.009) represents a critical methodological finding with implications for HRV research standardization. This finding aligns with established literature acknowledging device-dependent HRV variability and underscores the necessity for within-device consistency in longitudinal autonomic monitoring protocols[5].

Limitations: The limited sample size for participants limits this study. Confounding factors such as external stress could not be controlled for. While participants were monitored during HRV measurement and all measurements were conducted in the same location under similar conditions, participants were not instructed with regards to their rate and rhythm of breathing. Participants were not screened for any TART (tissue texture, asymmetry, restriction of motion, tenderness) findings prior to the study. No measurements with regards to Upper Cross Syndrome were taken during the study. A total of 7 Rhythm24 and 9 Sphygmocor measurements were excluded due to artifacts during measurement.

Future Studies: In future studies exploring the effects of Upper Cross Syndrome (UCS) treatments on HRV, a full screening of participants for UCS should occur, with results recorded at the beginning and end of study periods. It would also be beneficial to extend total treatment sessions to durations typically prescribed to patients with UCS. A potential longitudinal project could involve measuring HRV and UCS measurements at the beginning of a 4-week period. Separate recorders for HRV and UCS would enable blinding of measurements to prevent bias. Participants would then perform a full UCS treatment plan 3 times weekly for 4 weeks. UCS treatment routine would involve stretching and strengthening of all muscle groups involved with cervical mobility and posture, as well as muscle groups involved with the shoulder girdle. With the differences noted between photoplethysmography and electrode-based devices, having HRV measured with electrode-based devices at the beginning and the conclusion of the treatment period would result in the most accurate measurements. However, including home-based electrode-based devices, such as heart rate chest straps offer an accessible means for participants to monitor daily changes in HRV metrics as well.

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